NAVY'S ADVANCED AIRCRAFT ARMAMENT SYSTEM PROGRAM
CONCEPT OBJECTIVES

T. M. Leese and J. F. Haney
Naval Weapons Center
Code 31403
China Lake, California 93555, U.S.A.

SUMMARY

The Advanced Aircraft Armament System (AAAS) was originally chartered to improve armament equipment performance, support, and interoperability. Because of funding constraints the AAAS Program has been increasingly directed to development of air armament interface standards and technology, while advanced concept development of suspension release and stores management equipment has been de-emphasized. The current program concentrates on supporting the Joint Navy/Air Force Aircraft Armament Interoperable Interface Program whose task is development of MIL-STD-1760 (Aircraft Electrical Interconnection System) and associated guidelines for successful application.

Since the advanced concepts which were to be originally developed are a more appropriate subject for this paper, the context of the discussion is the program prior to the redirection. The Fleet needs and deficiencies which provided the requirements for the concept effort are briefly outlined, the objectives and goals are detailed, and the approach to achieve mission flexibility and performance improvements at reduced ownership costs is discussed. A key aspect of the approach is development of generic designs which capitalize on cost and growth advantages of standards while allowing incorporation of advancing technology.

INTRODUCTION

The Advanced Aircraft Armament System (AAAS) Program began at the Naval Weapons Center in October 1978. Original objectives included development of advanced stores management system (ASMS) and suspension release equipment (S&RE). Initial program goals also comprised armament performance and supportability improvement as well as future aircraft-weapon interoperability. Currently the program has been redirected to emphasize the interoperable interface standards and design guidelines for successful future SMS implementations on fighter and attack aircraft. These interface standards are being developed under the joint Aircraft Armament Interoperable Interface (AAII) Program in cooperation with the Air Force Armament Laboratory, Eglin AFB, Florida. The standards are incorporated as physical, electrical, and logical portions of the MIL-STD-1760. An electrical signal set was released 1 July 1981, and Notice 1 is soon to be published documenting intermateability characteristics of the connector portions (physical) of the standard.

This paper will not discuss the AAAS Program as now chartered, but will cover those original stores management technology objectives and approaches which were to be accomplished and which relate to avionics concept growth.

A Stores Management System, defined herein as an element of aircraft avionic and weapon systems, performs functions which include monitoring, initializing and controlling stores and the associated suspension release equipment. The SMS provides fault assessment, mode regression and jettison backup capabilities. In the past, SMSs have been developed on an aircraft-by-aircraft basis. The older SMSs are generally hardwired, not integrated, not automated, and they embody outmoded technology. Newer SMSs reflect more current technologies and far more effective integration and automation. However, it remains a fact that even modern SMSs are tailored to support the specific stores list and unique loadout configurations of individual aircraft types.

The discussion which follows will explain the source of requirements for improving stores management designs, the resulting objectives, and finally some of the useful concepts which have emerged. The program was active for approximately three years during which time interaction with Fleet users and industry produced a series of technical area reports and a contract statement of work and specification. Currently, two contracts are in place and system analyses have begun that will result in design specifications for an advanced generic system. During initiation of the contracts, an attempt was made to maintain an awareness of the main thrusts in avionics design and integration. Some of the concepts evolved during performance of the contracts may have application to avionics integration or at least may be useful in defining the evolution of stores management for follow-on avionics systems effort.

SYSTEM DEFICIENCIES AND REQUIREMENTS

In the seventies, a number of studies were initiated to identify those functional interfaces between a ship's company, air armament equipment, and standard operating procedures which impact mission effectiveness. The proliferation of aircraft armament equipment was determined to be a significant source of operational and support problems, and it was recommended that aircraft armament system interfaces be controlled in the future to minimize such proliferation.

The initial studies also identified characteristics and functions of the mission cycle which were deficient in capability and required performance improvement. Many of the deficiencies, such as lack of availability and/or selection in weapon systems, impacted numerous elements of the larger Navy Fleet missions; these deficiencies also were directly

	HUMAN INTERFACES			EQUIPMENT INTERFACES		TOTALS
	SWITCHES	CONTROLS	MONITORS	COMPUTER	OTHER	
	7	10	4	4	24	49
	2	18	5	1	16	42
	4	10	4	3	32	53
	4	10	4	2	21	41
	3	9	3	1	18	34
	3	4	4	1	15	27

Figure 2. Navy aircraft armament interface proliferation
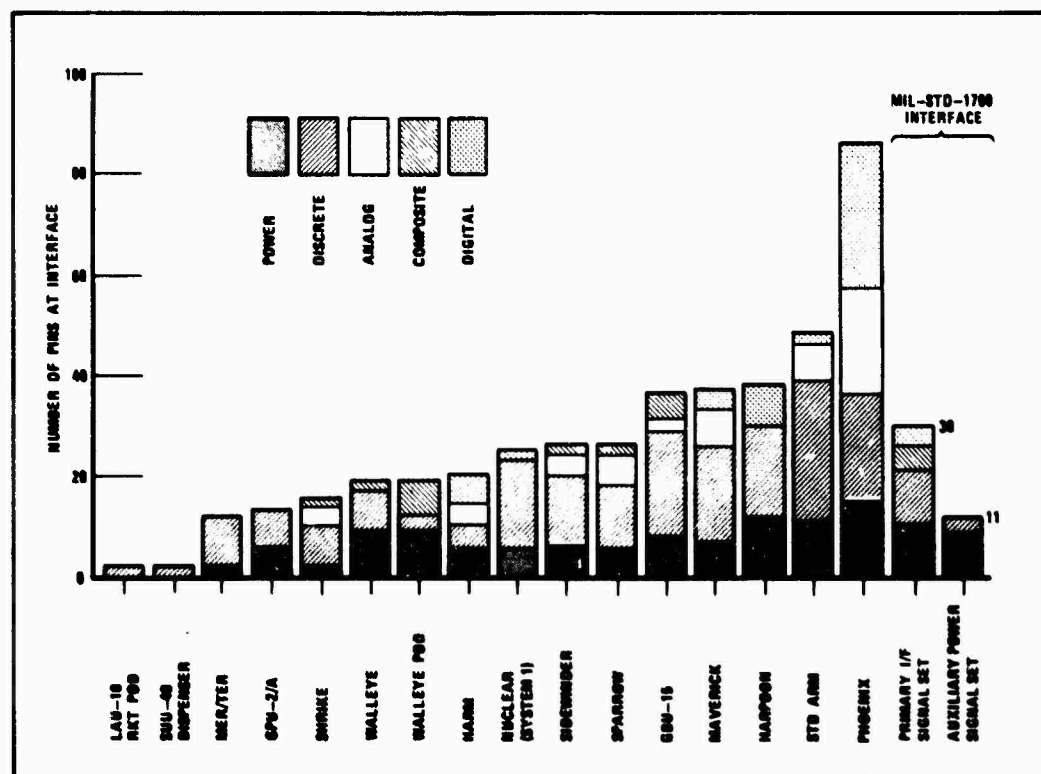
Figure 3. Relationship of growth in weapon signal complexity to MIL-STD-1760 electrical signal set

AAAS APPROACH

In response to these needs the overall objective of the AAAS Program became not only standardization of weapon-to-aircraft interfaces but to do so without restricting technology and design improvement growth. This required coordination with all affected groups to develop interface associated equipment design guidelines for improved performance. These design guidelines would also include standards which it is believed would halt the proliferation of interfaces and help in achieving low cost growth and support objectives (see Figure 4). Although this objective covered suspension and release equipment this paper only discusses the stores management equipment and briefly the standard interface.
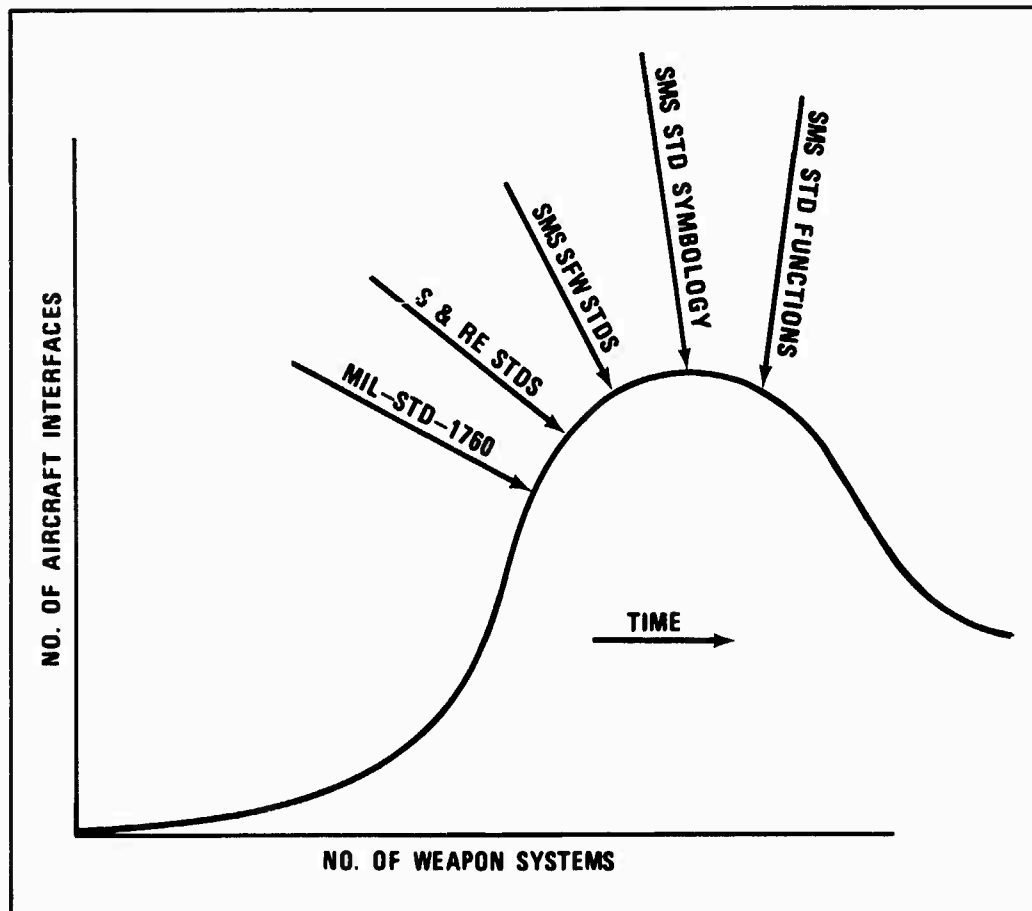
Figure 4. Development and implementation of standards to reduce armament interface growth.

Figure 5 summarizes the major AAAS objective, the required products, and lists the expected benefits and approach. Besides the AAII joint program, a laboratory tool was necessary to investigate options, and test design guidelines and validate standard decisions. The ASMS laboratory proposed, and which is now partially constructed, is shown in Figure 6. This lab configuration requires the development of future store and aircraft simulators and stimulators, an advanced stores management subsystem of a generic nature, and a computerized data base and software necessary to drive the data base.

In the ASMS laboratory, coded data will be transmitted over twisted-wire pair, internal time division, command/response, multiplex data buses which meet MIL-STD-1553 requirements. The control/display equipment will employ integrated multifunction, multicolor displays with preprogramed built-in-test diagnostics and control options through a dedicated control panel. The store station equipment (SSE) will be a distributed family of programmable microprocessors which code/decode message transmissions and process messages to control power switching functions and communicate with interfacing stores. The SSE will be preprogrammable to be compatible with interoperable carriage and mission stores. The central processing unit will be preprogramed for command and control of appropriate mission scenarios and tactical contingency options.

The ASMS laboratory system will be used to control and exercise the MIL-STD-1760 electrical interoperable interfaces, allow development and assessment of future Navy aircraft specifications for SMS, and validate developed armament implementations. The advanced stores management laboratory will include signal control equipment, displays and controls, store station equipment, data transfer equipment, and stores management processor software. Stores management subsystem concepts and alternatives to be validated include: digital data bus architecture between the stores management processor, store station equipment, and the display and control panel; and very high
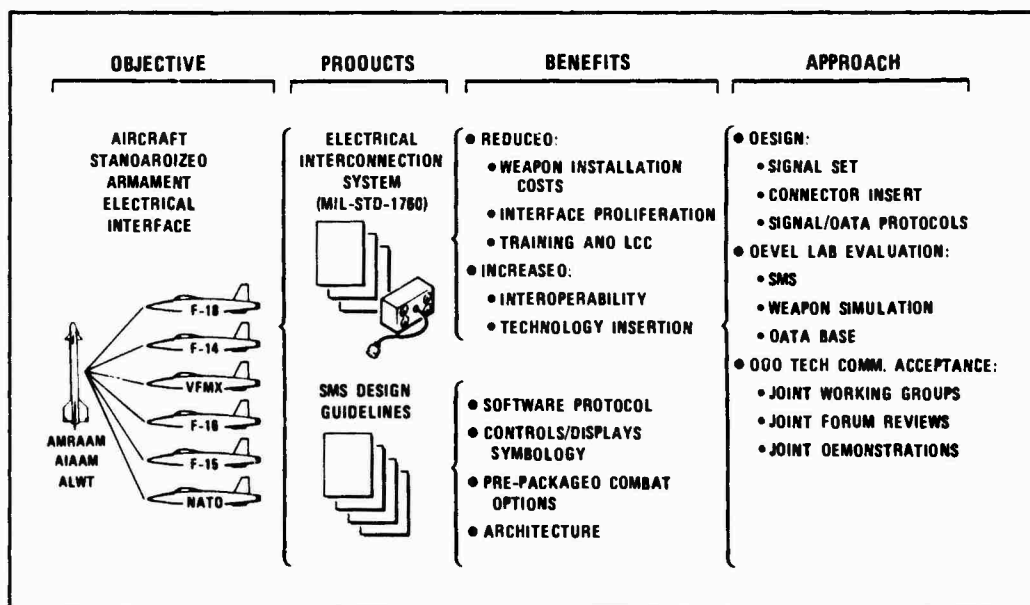
Figure 5. AAAS program essential character*stics.
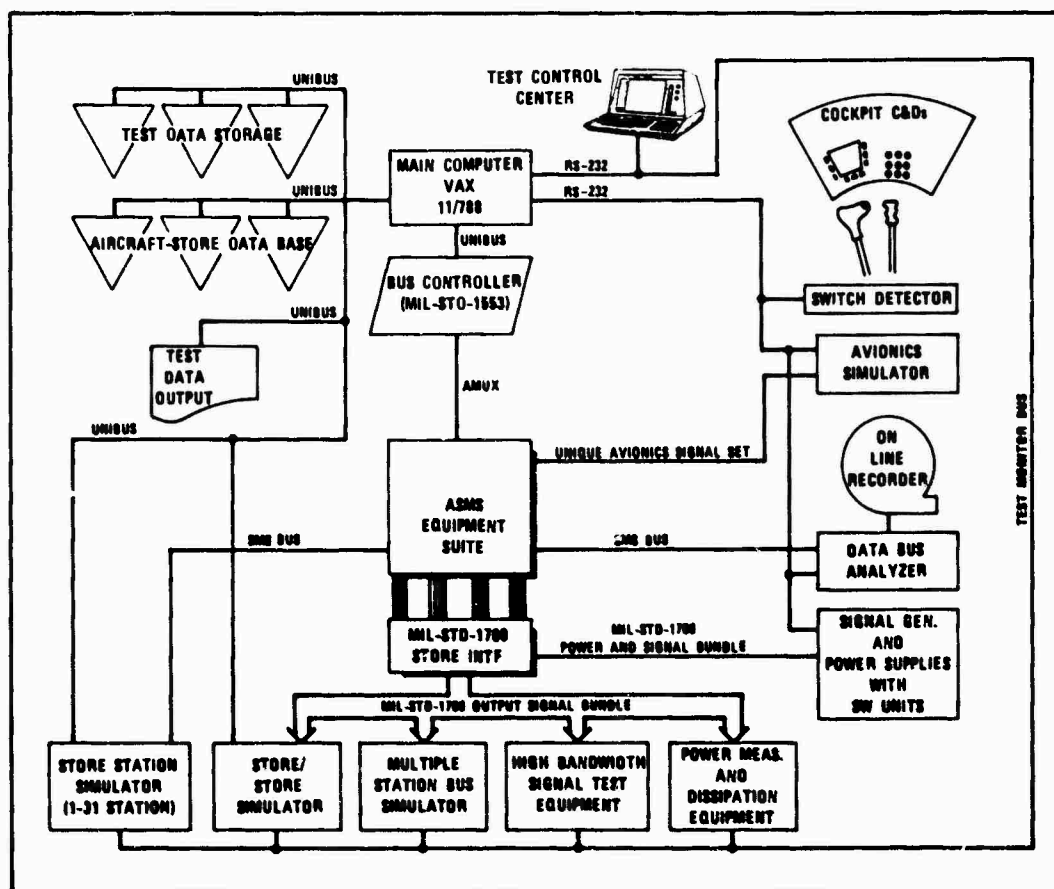
Figure 6. Advanced SMS laboratory for the study of interface and SMS requirements

speed integrated microelectronic devices/packaging for store stations in adverse environments. The ASMS laboratory will also be employed to evaluate stores management equipment architecture optimized for reduced crew workload, subsystem operational flexibility and survivability, and inflight degraded mode operational assessment. SMS programmability concerning the addition of future weapons to an aircraft store suite with minimum cost and time will also be studied in the ASMS laboratory.

A series of contracts were awarded and engineering studies conducted to define:

   (1) the signal, states, and control characteristics of future projected and existing weapon systems,
    (2) information and electrical power transfer characteristics across the weapon-to-aircraft interface,
    (3) obstructions to operability
    (4) standardization alternatives as a function of several system characteristics,
    (5) generic SMS and laboratory software and hardware architecture options, and
    (6) several studies relating to special SMS or interface system problems.

The results of these studies were used to generate inputs to MIL-STD-1760, to prepare the ASMS contract specification, and were also given to industry bidders as background in bid preparation. In order that the joint interface standards and SMS design guidelines efforts would be successful and provide a broader search for engineering solutions, two contracts were awarded, one by Navy AAAS and another by Air Force AFATL through the Navy.

Although the AAAS development efforts are not complete, some emerging concepts may be of interest to the avionics community. These concepts representing only a portion of those developed will be discussed in the next section.

CONCEPTS

The concepts worthy of discussion at this time evolved from the systems analysis efforts directed at defining and evaluating standardization opportunities, rationales and requirements. Valuable concepts were also gained from the ASMS contractors bid responses to the SMS engineering functional requirements developed during 1979-1981. They will be briefly illustrated and discussed in the following order:

Store-to-aircraft standard interconnection system
— obstructions to operability
— operability levels

SMS architectures
— multiple buses and distributed processing
— total aircraft data network
— fiber optic application
— software development tools

SMS subsystem standards
— data transfer
— software
— digital process control
— briefing entry device

STORE-TO-AIRCRAFT INTERCONNECTION SYSTEM CONCEPTS

The development of criteria for assessing interface standards effectiveness and selecting standardization alternatives for MIL-STD-1760 resulted in concepts which may have application at other aircraft and avionics interfaces.

Obstructions to Operability

The first of these concepts is the definition and decomposition to design level of the characteristics which are preventing or obstructing operability at the interface. Although this appears at first glance to be normal design analysis, its rigor makes possible the development of operability levels for assistance in subsystem integration and standards selection. Six of the nineteen obstructions to operability developed for MIL-STD-1760 are decomposed in Table 1 as an illustration of the concept.

Operability Levels

The second concept is the technique of structuring operability levels in ranked order of decreasing system impact top to bottom. This arrangement allows the development and comparison of standardization alternatives for various desired integration objectives or degrees of standardization.

Table 1
OBSTRUCTIONS TO OPERABILITY CONCEPT

Obstruction	Underlying Deficiencies ot Design Level

1. Foilure of connectors to mote ot the interface	• Different number of connectors at the interface
	
	• Different locotion, orientation, and loyout of connectors with respect to the mechanicol mounting interface
	
	• Different connector shell mechonicol types (locking mechonism, etc.)
	
	• Different connector shell size
	
	• Different connector insert detoils
	
	  - Number ond size/type of pins
	  - Arrongement of pins of eoch size/type
	  - Pin connection mechonism detoils
	
	• Different convention regarding which side of interfoce has which sex of connector
	
	• Different connector materiols (electrolytic compatibility, etc.)
	
	• Different connector shielding and grounding provisions

2. Lock of circuit continuity (or proper circuit termi- nation) ot the interface	• Different number and definition of circuits at the interface • Different ollocotion of circuits to various connectors (in a multi-connector interfoce) • Different allocotion of circuits to connector pins (or other interfoces such os for fiber-optics circuits) within o given connector • Different termination of circuits thot do not pass ocross the interfoce
3. Circuit incompatibility on the two sides of the interface	• Different impedonce ond/or tronsfer function chorocter- istics of the vorious circuits • Different circuit bandwidths on two sides of the interface • Different circuit noise immunity on two sides of the interface • Different circuit current capobility on two sides of the interface • Different circuit fault protection provisions on two sides of the interface
4. Woveform incompatibility on o given circuit	• Different maximum amplitude on two sides of the interface • Different basic or clock frequency on two sides of the interface • Different waveshape on two sides of the interface • Different signal stability on two sides of the interface • Different signal spectral distribution on two sides of the interface
5. Waveform incompatibility between two or more glven circuits	• Different phase relotionships between given circults on two sides of interfoce • Different polarity relationshlps between given circuits on two sides of interface
6. Incompatibility of network architectures	• Hierarchy of buses different on two sides of Interface • Locotion of intelligent terminals/bus controllers different on two sides of interface • Distribution of intelligence to subsystems different on two sides of interface

12-8

The interface system described in Table 2 may be standardized at different levels, i.e., for a given aircraft-store pair, the boundary between the standardized portion of the interface and the unique portion of the interface may be drawn at different levels. For an interoperable interface, all pairs using the interface design will have the same degree of standardization; however, the extent of the interface that must be designed uniquely may be different for each individual pair. The overall impact of the interface specification on the aircraft-store systems, therefore, depends on both the standardized portion and the individual custom portions.

From the lowest level to the topmost level, each succeeding level of operability builds upon the previous level to provide an increasing degree of standardization. The complete set provides complete electrical operability between aircraft and stores.

Clearly, standardization at increasing levels will provide greater degrees of operability and interoperability. However, the higher levels of standardization may impose increased system costs or undesirable system constraints. Therefore, it is necessary to evaluate succeeding levels of standardization to determine the benefits and identify associated costs and risks.

Table 2

OPERABILITY LEVELS CONCEPT

SMS ARCHITECTURES CONCEPTS

The two ASMS contractors initially responded to the contract specifications and requirements with proposed architectural configurations which indicate a direction for integration with other avionics systems.

Multiple Buses and Distributed Processing

Digital data bus architectures can be evaluated and selected by defining and developing the following parameters:

Information transfer redundancy   Efficiency (quality)

Information latency   Overhead (burden)

Throughput (Bus capacity)

Because system data latency is proportional to the number of interconnected buses and the "inter bus" data transfer rates, the bus architecture becomes a key area for careful evaluation. The two selected contractors for the Navy and Air Force both proposed preferred architectures as proposal baseline concepts. Both of these, Figures 7 and 8 indicate multiple buses are desired for several reasons. A key reason is the flexibility and redundancy in distributing the digital processing made possible by these configurations. However, the tiering or layering of MIL-STD-1760 standardized interfaces made mandatory by multiple store carriers and future weapon configurations drives toward multiple buses with standardized characteristics. Experiments will be necessary to verify the effects on key system parameters.
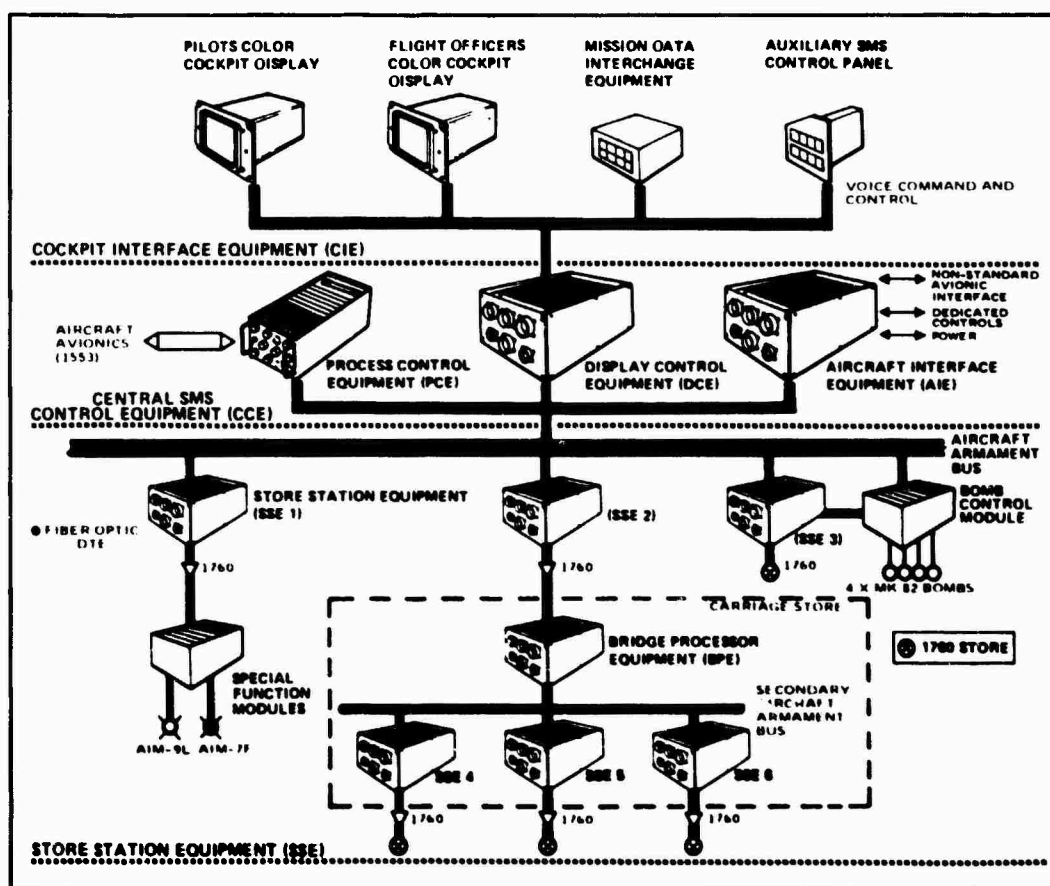
Figure 7. Contractor A baseline SMS configuration architecture
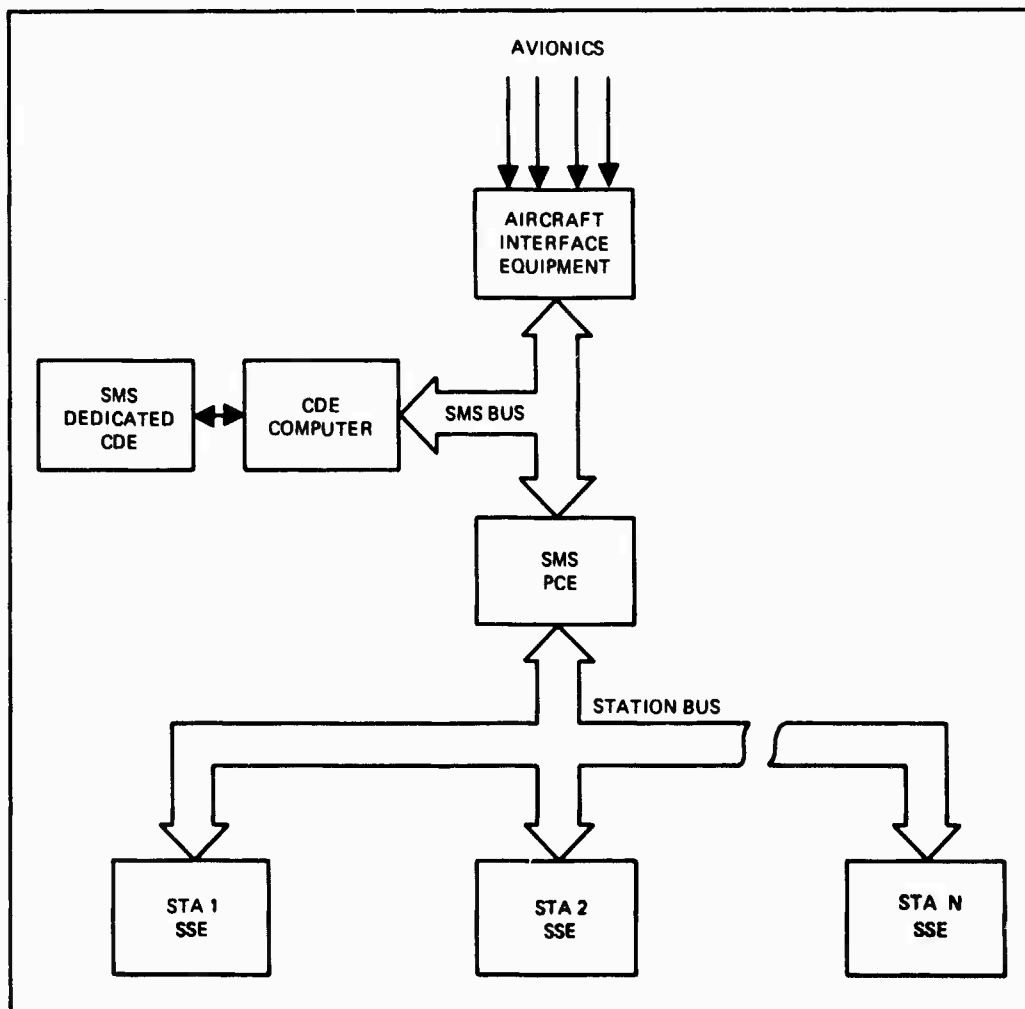
Figure 8. Contractor B baseline SMS configuration architecture

Total Aircraft Data Network

Many different digital data communication "buses" which do not conform to MIL-STD-1553 are used on current aircraft systems. The diverse system architectures and interface requirements of existing aircraft make necessary the provision for avionics integration modules or units, individually designed to adapt the SMS to the aircraft in which it is used. The expected functions required are easily discernable; they involve the common methods of data and control transmittal. The functional sizing, A-to-D converter size, number of DC outputs, word size of non-MIL-STD-1553 buses, etc., can only be derived from the specific application. Typically, the numerous, dissimilar I/O elements each have their own timing and response requirements.

In the use of the newer system designs, consolidation, sharing, and standardization of digital buses should yield large savings from reduced systems complexity. Further, if the whole data network of the aircraft could be controlled with standards to produce a common information transmission system into which technologically growing avionic subsystems could be exchanged, updated and replaced easily, all aspects of the aircraft mission readiness, and life cycle could be improved. Again, this is not a unique concept implied by SMS efforts alone and has been gaining favor in various design groups around the country. As the architectural and system trade studies progress, this total aircraft data network gathers more and more interest. Figure 9 shows how armament controls data bus requirements could serve as the initial source for integration and consolidation. The pilot interfacing with the aircraft weapon system during a mission, typically passes inward from mission and Fleet interfaces and actions, through aircraft systems and weapons systems interactions to the final weapon release. Common functions in armament controls leading back to common functions in weapon system support—leading to common interfaces with other aircraft and mission support functions—making possible important system integrations and simplifications.

Figure 9. Pilot interactions with avionics progress from top to bottom

Fiber Optic Application

The airborne fiber optic studies over the last several years coupled with the success of the communications industry in applying this technology has peaked the interest of system designers. The advantages are numerous and the current disadvantages almost as numerous. The AAAS intent through '79, '80 and '81 was to attempt the implementation of an advanced fiber optic SMS. Fund shortages and industry evaluations of technical risks caused the objective to be dropped in fav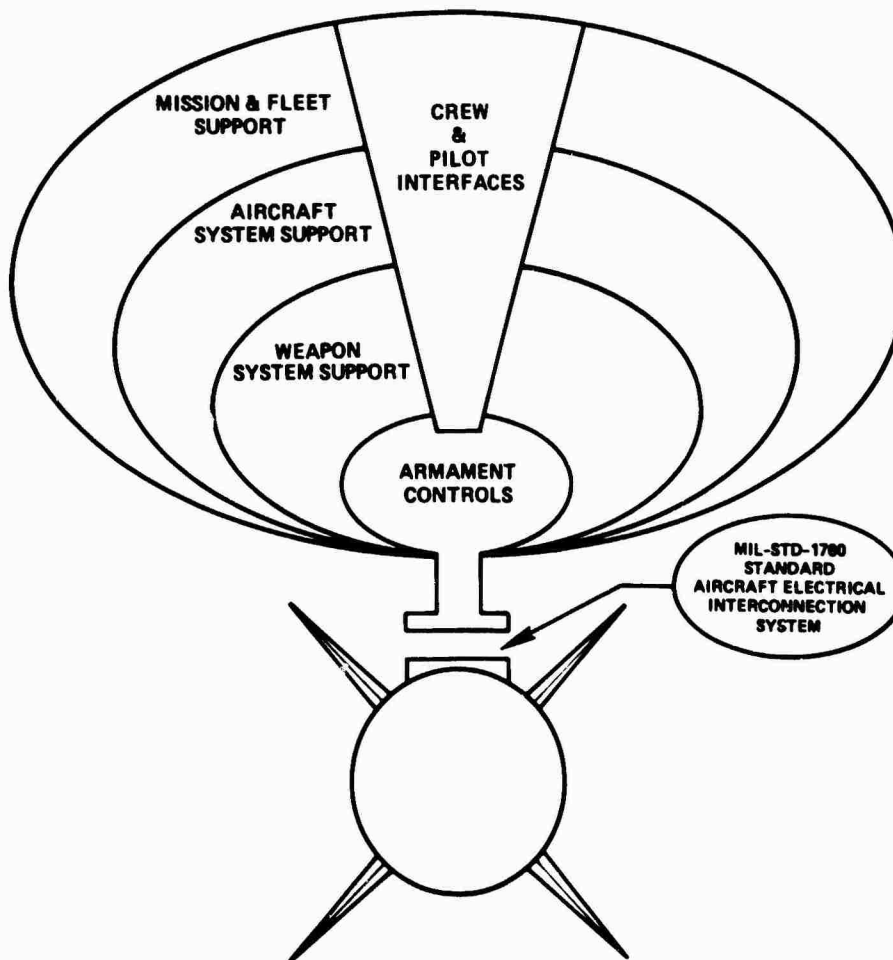or of wire-based. However, several proposals of fiber optic SMS configurations were received and evaluated in the process of awarding the current contracts. As components mature airborne fiber optics could become a reality. Figure 10 shows the impact of fiber optics on the specific architecture shown in Figure 8. The SMS configuration will include five identical digital fiber optic data buses: (a) avionics bus, (b) stores management bus, (c) left-wing store stations bus, (d) fuselage store station bus, and (e) right-wing store stations bus. Each bus employs a six-terminal reflective star coupler and single-fiber cable pigtails (without connectors).

The resolution of two critical issues arising from prior fiber optics development of airborne applications was completed and may be of interest. An analog decoder technique was successfully used to eliminate the signaling errors typically encountered in fiber optic data bus systems which employ 2-State Manchester Coding. An improved LED driver technique was developed which provides increased output power at wide bandwidth. Both techniques can now be exploited in airborne fiber optic system design effort.

Software Development Tools

A major objective of the AAAS effort is to develop systems hardware and software which provides rapid, very low cost, minimum modification, and capability growth. The addition of new weapons to older aircraft weapon suites represents this need. One of the contractors selected for the ASMS development will implement a concept which simplifies the generation of store control procedures, store control tables and specific aircraft application configurations. The system generation portion of this new tool is diagramed in Figure 11. Development of this tool provides adaptability to reconfigure software among various processors while minimizing any software programming. It utilizes table driven software to facilitate control sequence changes and simplifies addition of new stores to the SMS.
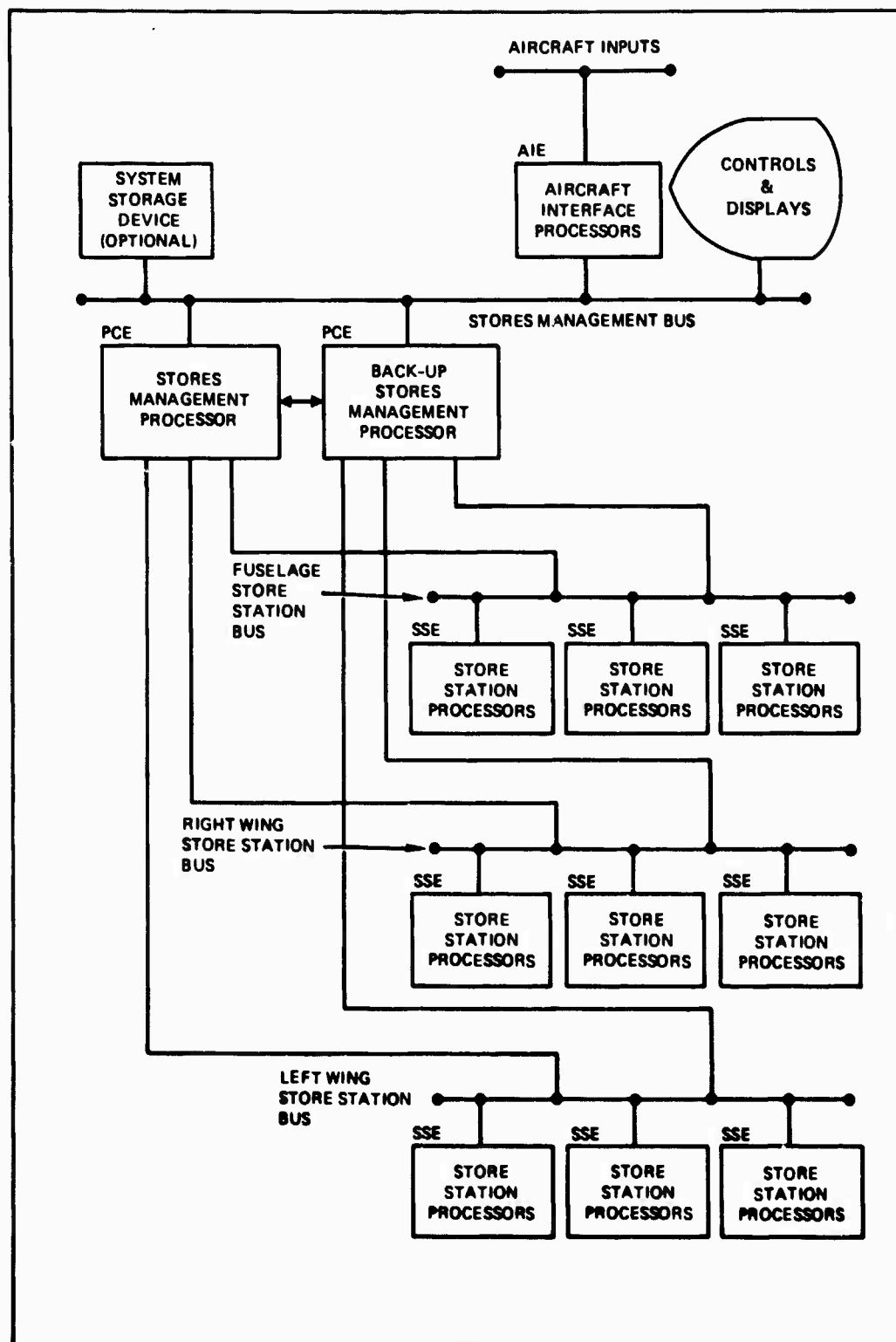
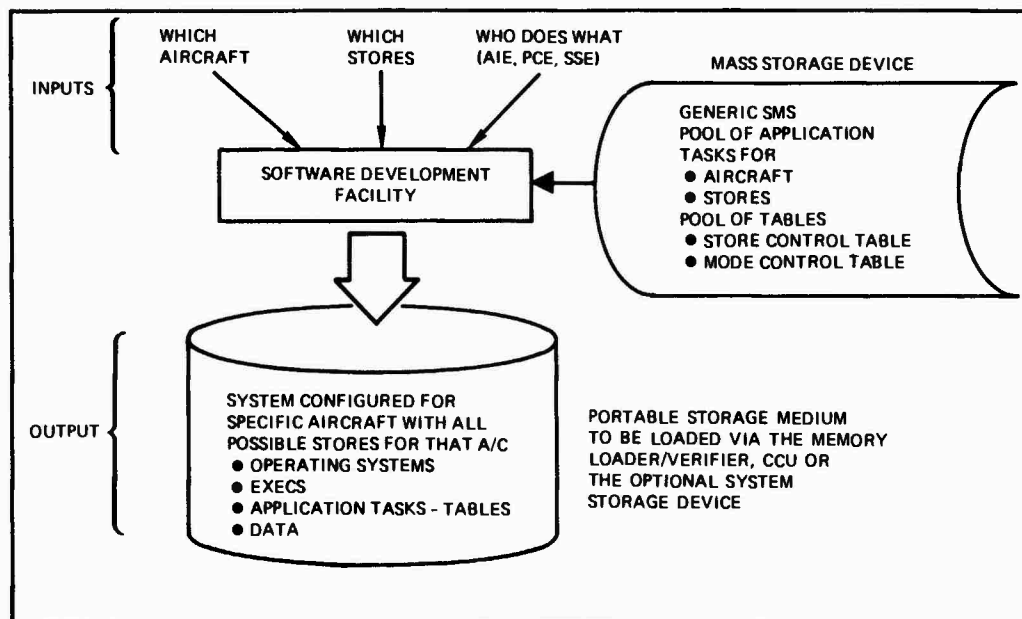Figure 10. Contractor B SMS architecture with fiber optics data buses

Figure 11. Store data software system generation

Use of the system by the Navy and eventually the AAII would enhance the concept of a DoD wide weapon aircraft system data base by providing a guide for data formatting and management.

SMS SUBSYSTEM STANDARDS

A concept which may be utilized for the evaluation of standardization in other avionics systems has been developed under AAAS direction effort. A set of criteria were developed to rank subsystems modules or components (levels) for the application to standardization by any of several approaches.

Standardization is the process requiring conception, formulation, dissemination, enforcement, and revision of standards. Six types of standardization are frequently used in Government and industry. These standardization types are summarized below.

Horizontal
Vertical
Area
Functional
Logistical
Cooperative

Horizontal standardization, also termed general, commodity, or intersystem standardization, refers to standardization of items (subsystems, modules or components) used between or within systems. An item used in more than one system (e.g., utilizing an AN/AYK-14 in more than one aircraft series) may also be used by more than one military service and often satisfies multiple missions. Example is AN/AYK-14.

Vertical standardization, also known as specific, project, product, or intrasystem standardization, refers to standardization of a project or product from design to operation. Vertical standardization includes an item used in all configurations of a single system. Example is AN/AYQ-9 in all F-18 aircraft.

Area standardization is standardization of items by geographic or mission area rather than between or within systems. When there is more than one supplier or application of a given item, these items are typically similar but not identical. Therefore, to meet area or mission needs, items are standardized within a mission or geographic area, whereas similar but not identical items are used between areas or missions. Example of area standardization is to use functionally similar items for strike and surveillance aircraft, but identically standardized items in a specific mission area (e.g., strike aircraft).

Functional standardization, also known as form, fit and function (F^3) standardization, is primarily concerned with the standardization of electrical, mechanical, logistical, and environmental interfaces. Items built to F^3 standards may differ significantly internally, but always have identical size, shape, and function. Commercial airlines have employed this form of standardization for many years in the specification of avionics. This form of standardization is also used to establish joint service standards (MIL-STD-1760) and NATO standards (STANAG 3837AA).

Logistical standardization is the specification of every aspect of an item, including the detailing of its parts, processes, and configuration. Examples of logistical standardization are military-qualified electronic components managed by the Defense Electronics Supply Center. Each logistically standardized item is identical in every respect to other standardized items.

Cooperative standardization is the development of design standards (examples include threads, fitting sizes, and materials) by all users, both industry and DoD.

Standardization studies conducted over the past few years have recognized that not all items make good standardization candidates, for technical, operational, or economic reasons. Presently there are no universally accepted, quantitative measures for determining the attractiveness of a particular subsystem for standardization. However, general guidelines for making such evaluations have been developed in recent AAAS studies. Four general selection criteria were developed and applied that were widely accepted by the R&D community. These criteria are briefly as follows:

Technological - The technology must be mature.

Architectural - The subsystem must perform identifiable, discrete, and separable functions.

Applicability - The system specification must be broadly applicable to weapon system requirements.

Economic - A sufficient market must exist for new systems within the period under consideration.

It is realized that these criteria are not a comprehensive set of considerations for selecting standardization candidates; however, a review of SMS subsystems against these factors encourages a disciplined examination, providing useful insight into the issues that must be reconciled.

Table 3 categorizes these criteria for ranking the seven AAAS SMS subsystems for potential standardization. Table 4 shows the results of applying the criteria and rationale together with each subsystem candidate's raw score and ranking.

Table 3   STANDARDIZATION-RANKING CRITERIA FOR SMS SUBSYSTEMS

Criteria	Category		
	Least Attractive (1)	Moderately Attractive (2)	Most Attractive (3)
Technological	Performance requirements change frequently; state-of-the-art pacing equipments.	Functionally similar equipments exist in the inventory. Improvements (primarily packaging, reliability, etc.) are expected.	Previous standardization precedent exists. Equipment currently exhibits high MTBF using proven technology and mature designs.
Architectural	High degree of interconnectivity with other avionics subsystems; moderate or higher degree of software implementation within subsystem.	Low degree of interconnectivity with other subsystems; moderate or higher degree of software implementation within subsystem.	Low degree of interconnectivity with other subsystems; very low software implementation.
Applicability	Used only in aircraft with similar performance characteristics or that operate in identical threat environments.	Used across multiple-aircraft types and in other military services.	Multiple mission and multiple aircraft or commercial usage.
Economic	Few suppliers and low annual demand rate — limited opportunity for competition.	Some suppliers and medium annual demand rate — some opportunity for competition.	Many suppliers and high annual demand rate — unlimited opportunity competition.

Table 4 STANDARDIZATION SCORES AND RANKING FOR SMS SUBSYSTEMS

SMS Subsystem	Standardization Criteria Application and Ranking					
	Technological	Architectural	Applicability	Economic	Raw Score	Rank
Control and Display Equip.	2	1	1	2	6	7th
Process Control Equip.	3	2	2	3	10	3rd
Store Station Equip.	2	2	1	2	7	6th
Aircraft Interface Equip.	2	1	2	2	7	5th
Data Transfer Equip.	3	3	3	3	12	1st
Software	3	3	2	3	11	2nd
Briefing Entry Device	3	2	2	3	10	4th

Note: 3 = Most Attractive, 2 = Moderately Attractive, 1 = Least Attractive

A discussion of the rationale for ranking the top four subsystems follows.

Data Transfer Equipment (DTE)

Data Transfer Equipment is considered most attractive for standardization based upon all criteria. DTE has standardization precedents (e.g., the MIL-STD-1553 multiplex data bus), highly standardized means for interconnectivity with other systems, and multiple mission/aircraft applications. Many companies supply DTE components, thus sustaining an unlimited opportunity for competition.

As a result of the above analysis, DTE was given the highest raw score of all SMS subsystems (12/12) and hence is regarded as the most attractive for standardization. All standardization approaches except functional are recommended, and standardization is achievable at all levels.

Software (SW)

The software subsystem is considered most attractive for standardization in all categories except applicability. Previous standardization precedent exists (e.g., standard HOL and MIL-STD-1679) and SW interfaces can be strictly defined through interface design specifications. Further, there are several potential suppliers of the SW subsystem, thus providing an unlimited opportunity for competition.

The SW subsystem as judged moderately attractive based on the applicability criterion, since only portions of the SMS subsystem (e.g., executive programs) may be used across multiple-aircraft types and potentially in other military services. It is expected that selected modules of SMS subsystems (e.g., application programs) will be needed to accommodate different aircraft configurations and store suites.

The SW subsystem accumulated a raw score of 11/12 and was judged the second most attractive of the SMS subsystems candidates for standardization. Standardization to the module level is considered feasible.

Process Control Equipment (PCE)

Process Control Equipment is rated most attractive for standardization on the basis of technological and economic criteria (see Tables 3 and 4). PCE scores well in these areas since there is precedent for its standardization (AN/AYK-14, AN/AWG-9, etc.), and such equipment utilizes proven technology and mature designs. Further, the many potential suppliers of PCE offer an excellent opportunity for competition.

PCE is considered moderately attractive for standardization based upon architectural and applicability criteria. The reasons are that PCE interfaces with other subsystems (although this interface is increasingly being simplified through the use of standard digital multiplexes busses), and typically differs in capability and mission supported.

The PCE reflects a total raw score of 10/12 (see Table 4) and ranks third overall as an AAAS subsystem candidate for standardization. PCE is considered feasible for standardization at all assembly levels and to all standardization approaches. However, functional standardization is not recommended since the logistical approach is achievable and has been demonstrated to the component level.

Briefing Entry Device (BED)

The Briefing Entry Device was judged most attractive based upon the technological and economic criteria, and moderately attractive for the architectural and applicability criteria. From a technological viewpoint, standardization precedent exists (e.g., Data Transfer System) and equipment making up the Briefing Entry Device incorporate proven technology and mature designs.

Further, there are many current suppliers of such subsystems, thus offering an unlimited opportunity for competition.

The moderately attractive ratings in the architectural and applicability areas were assigned, respectively, because the device (1) has a degree of interconnectivity with other subsystems, and (2) may not be adaptable across multiple aircraft types in a single configuration.

By applying the above criteria, the Briefing Entry Device attained a raw score of 10/12, suggesting that it is a favorable candidate for standardization. All standardization approaches except functional are recommended. Standardization to the module level is considered feasible, while complete component standardization may be difficult due to a requirement to adapt to different aircraft types and missions.

CONCLUSIONS

The series of concepts discussed above were selected for potential application or interest by other avionics developments. Due to a shortage of advanced development funds the application of these and other concepts may not be carried further by the AAAS program.

DISCUSSION

R.Davies, Ca

With regard to MIL-STD-1760 — has any consideration been given at Naval Weapons Center (or elsewhere) to extending the interface standard beyond the physical connection between the aircraft and the store (weapon missiles, etc.), for example, with a data link or wire-guided missile or a back link from an E-O weapon etc?

Author's Reply

To my knowledge no one is looking at this or for that matter pushing it. My instinct would be to let it mature a bit before standardization.

M.Burford, UK

In your presentation, you have identified that where there is a software interface, the standardization of the stores management system is "unattractive". This appears to be in direct contrast, in respect to standardization, to previous speakers. Could you please outline the thoughts which have led to this conclusion?

Author's Reply

Somehow we did not communicate well. The section in my paper on SMS subsystem standardization states very clearly that the software as an SMS subsystem is a most attractive candidate. I believe this to be in agreement with most other speakers.

K.F.Boecking, Ge

You presented two different architectures for a SMS. In system "A" the display/control system corresponds to the SMS via the avionics-bus. In system "B", the SMS-Bus has its own D/C-system at the SMS-Bus. Could you explain the reason for a separate D/C-system in the "B"-SMS?

Author's Reply

The separate controls/displays functional block on SMS system "B" is for the safety required separate discrete controls which cannot be integrated into multi-function controls through the avionics bus. Actually, all proposals received were identified in this characteristic including SMS "A". A look at the SMS system "A" figure in the paper will confirm this.

L.Wildharer, Ca

Are you considering standardization or adoption to commercial digital bus system, that is, the use of ARINC Bus 429 for interphasing between standard commercial avionics systems (digital) and aircraft weapon systems? This refers to Table 3 Applicability — Most attractive (3).

Author's Reply

Yes, under study with regard to input-output parameters for standardization.

G.R.England, US

(1) Future for SMS implementations where real time data is required will likely be a network rather than a hierarchal bus system. A switched network would be applicable to any type of real time requirement.

(2) Master arm type data is generally made available to the rest of the avionics by means of a discrete to the Fire Control Computer. By this means, the data can be put on the bus yet retain necessary isolation for safety.

Author's Reply

(1) Yes, thank you, an excellent point.

(2) Again, thank you, for help in answering the question from Germany.